Decision Problem of Instrumentation (metering) in a Company involved in ISO 50001

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Agence de l'Environnement et de la Maîtrise de l'Energie

SAVOIE & HAUTE SAVOIE
L'ASSEMBLEE
PAYS DE SAVOIE
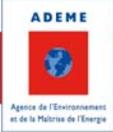
Bastien RIZZON Vincent CLIVILLE Sylvie GALICHET
LISTIC Université Savoie Mont Blanc France

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Summary

▶ INTRODUCTION

▶ PRELIMINARY ANALYSIS OF ENERGY CONSUMPTIONS

▶ DECISION PROBLEM

▶ ELICITATION OF THE PREFERENCE MODEL

▶ CONCLUSION

General Context

- Potential gain to be about 30% on the energy consumption (ISO)
- ISO 50001, Energy Management Systems Requirements with guidance for use
  - Develop a policy for more efficient use of energy
  - Fix targets and objectives to meet the policy
  - Use data to better understand and make decisions concerning energy use and consumption
  - Measure the results
  - Review the effectiveness of the policy
  - Continually improve energy management.

Pfeiffer Vacuum Context

- Vacuum technology and leak detection area
- Vacuum pumps designer and producer
- Certification ISO 9001 and 14001
- Continuous improvement approach (Adixellence)
- Sustainable development motivation (Green LabFab project 2010-2014)
- Objective of Energy Control in the ISO 50001 perspective

Preliminary question: how to measure the energy consumption

> Automatic Monitoring and Targeting (AMT) systems, also called "metering"

> Common practice for company: single global point for a given location (plant, factory…) available directly with a counter or indirectly through the related bills

> In fact: hundreds maybe thousands of consumption points

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Decision problem

> Which consumptions points must be instrumented, in a first step?

> Two extreme solutions:
>   – Total instrumentation: technically very interesting but very expensive
>   – Current instrumentation: free of charge but not enough to identify the potential gains of energy

> Relevant solution between the extremes

Preliminary analysis

- Consumption must be handle at the process level thus be known at the same level

- Consumption is essentially electrical

- Company (plants) results of successive evolutions for more than 60 years then the electrical network is continuously modified

- Idea: identifying the Electrical network by an electrical "pieuvre" which is organized by levels from the global point to the elementary equipment

Nom du service
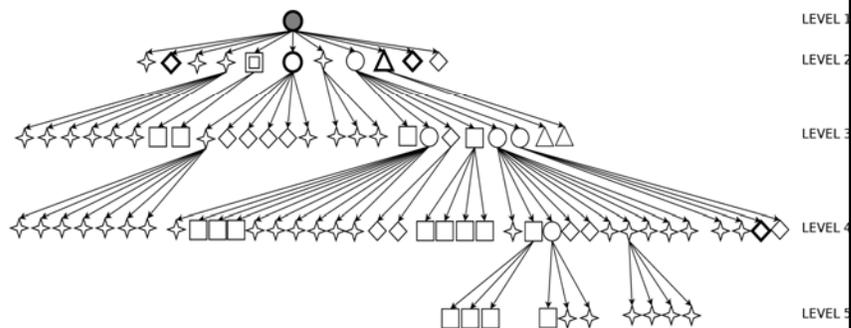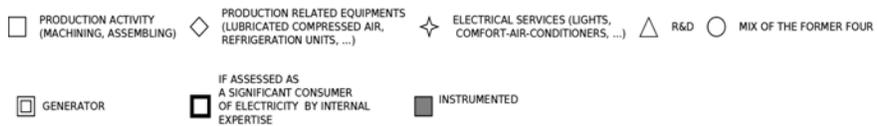
Detailed Decision Problem

- What should be the instrumented nodes in order to control the P substation consumption?
- Three related questions
  - What are the alternatives solutions?
  - What are the criteria of preference?
  - How to elicit the DM preferences?

Considered alternatives

- Initial Instrumentation (a01)
- Exhaustive Instrumentation (a02)
- **Sub-global** Instrumentation (a03)
- Sectors of Activity Instrumentation (a04)
- Production Centered Instrumentation (a05)
- Handpi

LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
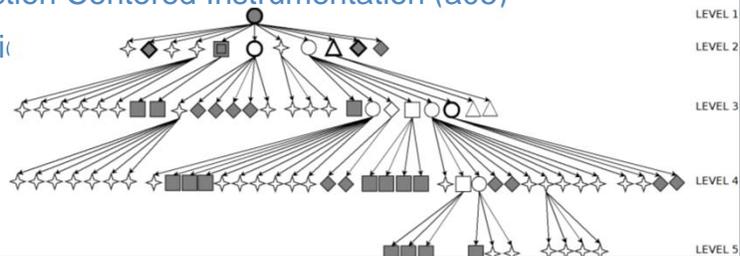
Considered criteria

▶ Fitness with the Governing Organization of the Company (g1) from 0 to 10

▶ Total Distance between the Points of Measurements (g2) from 0 to 200 m

▶ Durability of the Instrumentation (g3) from 0 to 24 months

▶ Expectation in a Gain for the Energy Management System (g4) among *low, medium and high*.

▶ Total Cost (g5) from 0 to 47600 €

Decision matrix

	g1	g2	g3	g4	g5
a01	0	0	24	Low	0
a02	10	200	6	Medium	48300
a03	7	10	20	Medium	7700
a04	9	120	12	High	16100
a05	8	80	6	High	19600
a06	6	5	20	Medium	4200

▶ No Pareto Dominance, what are the satisfying alternatives?

Preference model elicitation

> DM needs at least a ranking of the alternatives.

> DM is in a constructive decision aiding approach

> Based on the DM expertise

> The used method is the disaggregation method UTA, where the overall utility is the addition of the marginal (criteria) ones.

UTA method

> A set of criteria $C : \{g_1 ..., g_j\}$ defined according an interval value $x_j \in [\alpha_j : \beta_j]$

> A set of alternative $A : \{a_1 ..., a_i\}$ characterized according to the set of criteria by the decision matrix

> A set of reference alternatives $A_R \subset A$

> A set of preference relations on A_R

> Assumption of linear piecewise marginal utilities

> Assumption of criteria monotony

> Linear programming for solving the constraints

System of contraints

$$Max\ \varepsilon,\ \text{s.t.}$$

$$\left. \begin{array}{l} U(a) \geq U(b) + \varepsilon,\ if\ a \succ b, \\ U(a) = U(b),\ if\ a \square b, \\ u(x_j^k) \leq u(x_j^{k+1}), k = 0,...,\gamma\,j - 1, \forall j=1,...,n, \\ u(x_j^0) \\ \sum_{j=1}^{n} x_j^{\gamma-1} = 1 \end{array} \right\}$$

Post optimization processing: one solution in the constraints polyhedron.

DM choices

▶ Preference relations : $\quad a_{06} \succ a_{05} \succ a_{04} \succ a_{03} \succ a_{01} \succ a_{02}$

▶ 2 segments per criterion

▶ Post optimization method: Analytic Center UTA, ("as far as possible" from the boundary of the constraints polyhedron).

Marginal and global utilities
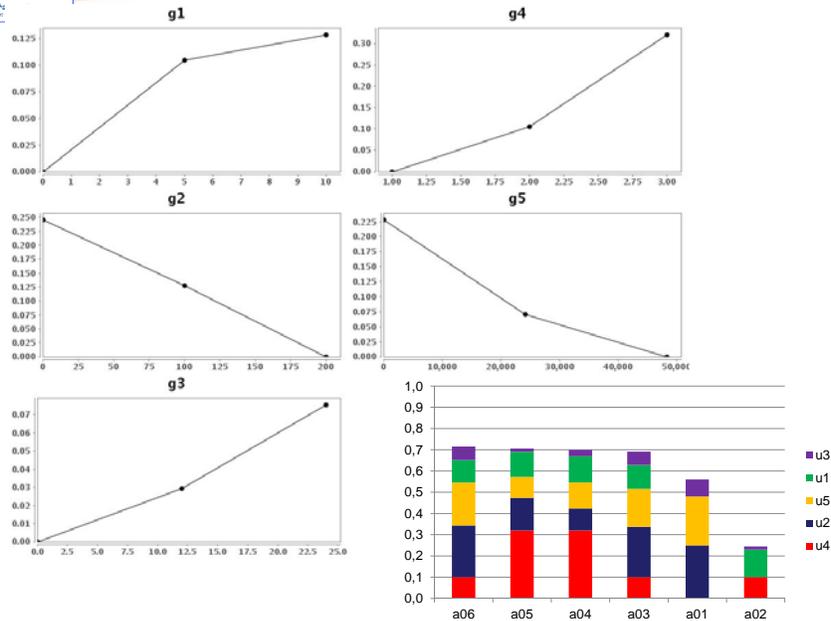
Discussion

> MCDA in Manufacturing Companies: it is possible moreover it asks implicit needs

> Learning from the company practice is compulsory, it must be done on the duration: identification of the real problem, pedagogy around the method…

> Method-model re-using is important

> There are limits about the mathematical aspects of the method (ROR), engineer wants to understand what is done with his/her data and knowledge.

Model re-using
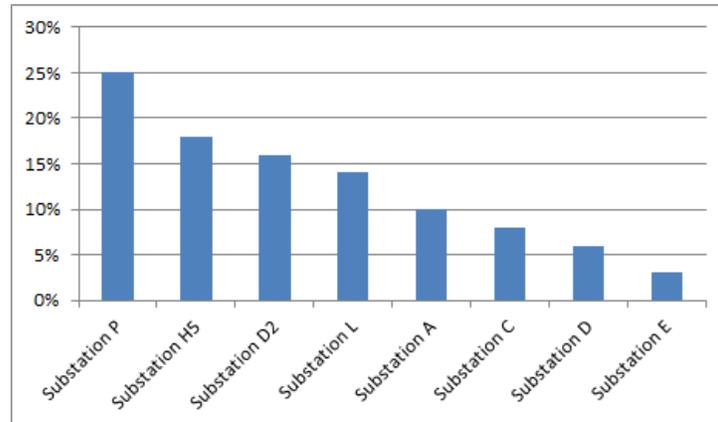
Other works and perspective

> Use of the preference model to design the other substations instrumentation

> Taking into account the imprecision of data

> Introducing the feasibility concept in the design-choice process

> Taking again the decision-aiding method for the other problem of the Energy Management System